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(54) Apparatus and method for slit radiography with different x-ray energies.

(57) In an apparatus for slit radiography a body (1) to be irradiated is scanned at least twice by means of a planar, fan X-ray beam (4) emitted from an X-ray source (1) via a slit diaphragm (2), the hardness of which beam increases with each next scanning motion.

An X-ray detector (6) mounted behind the body collects the radiation passed, and sections of detection means (10) juxtaposed in the longitudinal direction of the X-ray detector, produce electrical signals depending upon the radiation collected by the respective X-ray detector sections, which signals are sampled during each scanning motion and are stored in a memory (13). The diaphragm (2) includes controllable elements (22) juxtaposed in the longitudinal direction of the slit in a number corresponding to that of the sections of the detection means. The controllable elements are each operative to locally block the slit diaphragm during a next scanning motion if a stored signal produced by the corresponding secti n f the detection means during a preceding scanning motion exceeds a predetermined value.

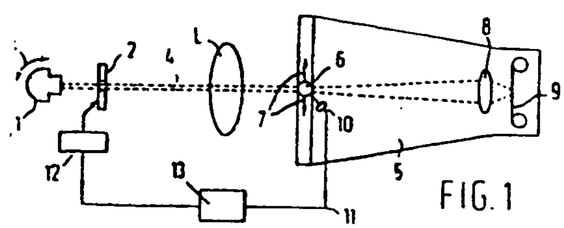

FIG. 1

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Title: Apparatus and method for slit radiography with different X-ray energies

The invention relates to an apparatus for slit radiography comprising at least one X-ray source, an X-ray detector disposed behind a body being irradiated to collect the radiation having passed through the body, and a slit diaphragm disposed between the X-ray source and the body being irradiated to form a planar, fan X-ray beam, in which for obtaining a complete X-ray shadow image of the desired part of the body the fan beam performs at least one scanning motion, and detection means are provided to coact with the X-ray detector, which detection means comprise a plurality of sections arranged in juxtaposition in the longitudinal direction of the striplike portion of the X-ray detector irradiated via the slit diaphragm, each section being adapted to produce an electrical signal depending upon the radiation instantaneously incident on the associated section of the X-ray detector, the slit diaphragm comprising a plurality of sections arranged in juxtaposition in the longitudinal direction of the slit, which plurality corresponds to that of the sections of the detection means, each of which section coacts with at least one controllable element, means being provided to control these elements.

Such an apparatus is disclosed in applicants' older Dutch patent application 84,00845.

The known apparatus comprises an elongate X-ray detector mounted to have its entrance surface collect at all times the radiation having passed through the slit diaphragm and the body being irradiated. The assembly of detector, X-ray source and diaphragm is so moved

relative to the body that the desired part thereof is scanned. The detector converts the X-rays collected into an intensified light beam used for exposing a photographic film. During the scanning motion the detection means measure the amount of light incident on each associated section of the X-ray detector, while the corresponding controllable elements in the slit diaphragm are so controlled in dependence upon this amount of incident light that they section-wise block the slit to a greater or lesser extent. This permits an instantaneous, section-wise control of the intensity of the radiation having passed through the body being irradiated, so that the recorded X-ray image will not include regions that fail to show detail on account of too large amounts of such radiation resulting in, for example, the film on which the image is recorded having too high a density in those regions.

It is known in radiography to preferably select the hardness of the X-rays in dependence upon the type and the amount of tissue to be irradiated. The hardness of X-rays is determined by the high voltage applied to the X-ray source and is usually expressed in kV, the higher the kV value the harder the X-rays.

Problems arise if a single radiograph is to show parts of the body that would preferably need irradiation with X-rays of different hardnesses. Such problems occur, for example, in thorax radiography, in which the lungs are preferably to be radiographed with low hardness X-rays so as to permit small differences in density in the lung tissue to be displayed with sufficient contrast. The high voltage to be applied to the X-ray source for such purposes will be, for example, 60 kV. However, other tissue to be displayed in thorax radiography, such as the heart and the spinal column, is preferably to be irradiated with X-rays of higher hardness, the voltage applied to the X-ray source, being, for example,

100-140 kV. Should, in thorax radiography, a body be successively irradiated with X-rays of different hardnesses, the final radiograph would only show detail in the regions irradiated with high hardness X-rays, while the other regions, such as the lungs, would not show any detail and be displayed completely black as too much radiation is passed by these regions.

It is an object of the invention to provide an apparatus that permits the making of a radiograph by means of X-rays of different hardnesses without certain portions of the radiograph becoming so dark that no details can be made out.

To this end, the invention provides an apparatus of the above type in which the X-ray source is arranged for performing at least two scanning motions and the X-rays emitted during the subsequent scanning motions each time have a higher hardness, in which the electrical signals of the sections of the detection means are sampled during each scanning motion, the sampled signal values are stored in a memory and during each next scanning motion the corresponding signals of the preceding scanning motion are retrieved from the memory to be applied to the control means, which control means energize those controllable elements that each time correspond to the section of the detection means that produced an electrical signal exceeding a predetermined value at a corresponding instant during the preceding scanning motion, the energizing signal being adapted to cause the controllable elements to block section-wise the associated sections of the slit diaphragm.

In accordance with the invention, during two or more subsequent scanning motions the body under examination is irradiated with X-rays of each time higher hardness, in which those regions of the shadow image that, according to the output signal of the detection means, already received a sufficient amount of radiation

during a stage in the preceding scanning motion for providing an image of sufficient contrast, do not receive any further radiation during the corresponding stage in the next scanning motion as the associated sections of the slit diaphragm are blocked. In this manner it is possible to combine two or more images of a body made with X-rays of different hardnesses into a single radiograph showing each tissue with optimum contrast.

It is observed that applicants' older Dutch patent application 84,01946 already discloses a system for forming a shadow image of a body by irradiating this body with X-rays of different hardnesses. However, in this system a separate electronic image is formed at each level of hardness, which images are subsequently combined into a single image, for example by means of a computer. In accordance with the present invention, this single image is obtained without any additional processing.

The invention also relates to a method for slit radiography, in which X-rays are emitted from at least one X-ray source and are formed into a planar, fan X-ray beam by a slit diaphragm disposed between the X-ray source and the body being irradiated, an X-ray detector disposed behind the body being irradiated collects the radiation having passed through the body, and for obtaining a complete X-ray shadow image the desired part of the body is scanned at least once, in which sections of detection means coacting with the X-ray detector, which sections are arranged in juxtaposition in the longitudinal direction of the strip-like portion of the X-ray detector irradiated via the slit diaphragm, produce electrical signals depending upon the radiation instantaneously incident on the associated section of the X-ray detector, the slit diaphragm comprising a plurality of controllable

elements arranged in juxtaposition in the longitudinal direction of the slit, which plurality corresponds to that of the sections of the detection means; in which the X-ray source performs at least two scanning motions and during the subsequent scanning motions X-rays of each time higher hardness are emitted, the electrical signals of the sections of the detection means being sampled during each scanning motion, the sampled signal values being stored in a memory and during each next scanning motion the corresponding signals of the preceding scanning motion being retrieved from the memory to energize those controllable elements that each time correspond to the section of the detection means that produced an electrical signal exceeding a predetermined value at a corresponding instant during the preceding scanning motion, the controllable elements section-wise blocking the slit diaphragm.

As in the apparatus according to the invention a relatively long period of time up to about one second, can pass between successive scanning motions, movements of the body being irradiated during that period of time might cause problems. However, as each part of the body being irradiated is recorded only once, the chances of unsharpness due to such movements are very small. Double exposure can occur only at the contours of two recording regions, but this does not result in unsharpness of the image. For example, in thorax radiography the contour of the heart may be visible at two different positions in the radiograph but this will not interfere with the examination of the radiograph and may even be useful in certain diagnoses.

The invention will be described in greater detail hereinafter with reference to the accompanying drawings, in which:

Fig. 1 schematically shows in sideview an example of an apparatus for slit radiography in accordance

with the invention;

Figs. 2a and 2b schematically show examples of a slit diaphragm for use in the apparatus of Fig.1;

Fig. 3 shows the manner in which the slit diaphragm of Figs. 2a and 2b can be partly blocked;

Fig.4 shows a number of embodiments of a slit diaphragm according to Fig.3 in cross-sectional view through the line IV-IV;

Fig.5 shows a slit diaphragm and the manner in which the effective slit width can be locally controlled; and

Figs.6, 7 and 8 show variants of Fig.5.

Fig. 1 schematically shows in sideview an example of an apparatus for slit radiography comprising at least one X-ray source 1 adapted to perform, together with a slit diaphragm 2, a pivotal motion as indicated by arrow 3. Slid diaphragm 2 causes a planar, fan X-ray beam 4, which performs a scanning motion in response to the pivotal motion 3 performed by X-ray source and slit diaphragm. X-ray source 1 can be arranged for generating X-rays of different, for example two, radiation energies, but self-evidently there can alternatively be provided a number, for example two, of X-ray sources each generating X-rays of a different radiation energy and each adapted to perform a pivotal motion 3 for successively producing via diaphragm 2 fan X-ray beams of different energies during subsequent scanning motions.

It is observed that a scanning motion of the X-ray beam can alternatively be achieved if the X-ray source is stationary and the slit diaphragm performs a translatory motion normal to the longitudinal direction of the slit, supplemented by a pivotal motion if desired, or if the diaphragm is stationary and the X-ray source performs a translatory motion supplemented by a pivotal motion is desired.

A housing 5 is disposed opposite to the slit diaphragm at sufficient distance therefrom to allow a body L to be positioned therebetween, which housing 5 includes an X-ray detector 6 having an entrance surface of sufficient size to collect the radiation having passed through the body being irradiated at all times during the pivotal motion of the X-ray source and the slit diaphragm.

In the example shown, an elongate tubular detector of the proximity focus type is used, which converts the X-rays collected into a light image while performing a vertical motion as shown by arrows 7 in synchronism with the pivotal motion of the X-ray source.

The successive strip-like light images provided by the detector are projected via a schematically shown lens system 8 onto a film 9 for forming a complete image from the successively projected strip-like images.

A light detection device 10 is mounted in the vicinity of X-ray detector 6, which device 10, seen in a direction normal to the plane of the drawing, includes a plurality of sections arranged in juxtaposition, which sections each measure the amount of light generated by a corresponding, opposite portion of the exit surface of the X-ray detector. To this end, in the example shown, the light detection device moves with the X-ray detector. The amounts of light measured by the sections of the light detection device during the scanning motion are converted in known per se manner into electrical signals, which signals are periodically sampled and applied through a line 11 to a schematically shown memory 13 in which the output signal of each section for each sampling is stored at a separate memory location. During the next scanning motion the signals stored in memory 13 are applied to control means 12. The control means are arranged for locally blocking the slit diaphragm. To this end, the slit diaphragm is composed of a plurality

of sections corresponding to the plurality of sections of the light detection device. In each of the diaphragm sections the diaphragm slit can be blocked in one of the manners to be described later on.

In illustration of the principle underlying the present invention, the thorax radiography example used above is now described in greater detail. First the film is exposed to the image produced by the soft X-radiation for optimally displaying the lungs. During this first scanning motion the slit diaphragm is fully open.

Simultaneously, at the exit surface of detector 6 detection device 10 registers at which positions the light level is high enough for causing sufficient film density. These positions are stored in digital memory 13 for each sampling during the first scanning motion.

The result is an electronic image of the portions recorded by means of soft radiation on the film with sufficient contrast. This image may consist of, for example, 20x30 pixels if the detection means are sampled 30 times in vertical direction and the detection means consist of 20 sections. Subsequently a second image can be formed on the same film, now with X-radiation of higher hardness, by means of which the heart and the spinal column can be displayed with sufficient contrast. To avoid double exposure in the area of the lungs, during this second scanning motion the controllable elements in the slit diaphragm are so controlled by control means 12, which to that end receive from memory 13 the electrical signals produced by the detection device at a corresponding instant during the preceding scanning motion, that the area of the lungs is fully shielded from X-rays. Consequently, this shielding takes place on the basis of the information provided by the image that was electronically recorded during

the first scanning motion.

The result is a single picture showing the lungs as well as the denser body parts with optimum contrast. Self-evidently, in this manner the film density it likewise kept within satisfactory limits. Furthermore, self-evidently the light detection device is so disposed that it does not obstruct the radiation between X-ray detector 6 and lens system 8.

Fig.2a schematically shows an example of a slit diaphragm for an apparatus according to the invention. The diaphragm includes an upper member 20, which may be of lead, and a lower member 21 having sections 22 adapted for movement relative to each other into the direction of the upper member. Sections 22 may likewise be of lead.

Fig.2b shows a possible position of movable sections 22 after radiographing with a first, low X-ray energy. The sections indicated by arrows have moved into the direction of the upper member of the diaphragm so as to locally block the slit.

In the example shown, ten movable sections are used which correspond to ten light detection sections.

In thorax radiography satisfactory results can be achieved by means of such a number of sections. Self-evidently if desired a different number of sections may be employed.

Fig. 3 schematically shows the manner in which the slit diaphragm sections shown in Fig.2 can be controlled. The sections of diaphragm member 21 are each connected through a member 30 attached thereto, for example a rod, to a, for example, soft iron coil core 31 adapted for movement within a coil 32 and kept in its rest position by reset means, such as spring means 31a or a magnet.

Each coil is energized through an output 33 of a control device 34. The control signal presented

at each output 33 depends on an input signal applied to a corrsponding input 35 of the control device, which input signal is supplied from the associated memory location of memory 13. The intensitiy of the current traversing a coil determines the position of the associated soft iron core and hence whether the diaphragm section coupled thereto is open or closed.

It is observed that in the example shown only one of the members of the slit diaphragm includes movable sections. Self-evidently it is possible to provide both slit diaphragm members with movable sections.

It is further observed that the movable sections of a diaphragm member are mounted jointly in a support member. The structure of such a support member is obvious to the worker in the art and will therefore not be discussed.

The movable sections of the one slit diaphragm member as shown in Figs. 2a, 2b and 3 may be of rectangular section, as shown in Fig.4A, which is a cross-sectional view through line IV-IV in Fig.3. In this embodiment, leakage of X-rays through interspaces or transitions between the sections could lead to stripes in the final radiograph. To reduce the chances thereof, the slit diaphragm sections may each be of trapezoidal section as shown in Fig.4B, which is a cross-sectional view corresponding to that of Fig.4A. Other variants are possible, such as the one shown in Fig.4C, in which the sections interlock through tongues and grooves.

Fig.5 schematically shows in sideview a further embodiment of a slit diaphragm suited for use in an apparatus according to the invention. This embodiment employs two fixed diaphragm members 50 and 51 defining a fixed slit S. For guidance, X-ray source 1 is schematically shown in Fig. 5.

A plurality of juxtaposed, elongate blocking elements is disposed in slit S, one of which is shown

in Fig.5 at 52. Blocking lement 52 xtends through slit S and is mounted for pivotal movement relative to one of the fixed diaphragm memb rs, in this example lower member 51, or relative to a suitably mounted support. Element 52 has its one end coupled to a movable soft iron core 53 of a coil 54 in the manner described above with reference to the sections shown in Fig.3. The soft iron core is further connected to a damping member 55 operative to prevent core 53 from overshooting upon energization of the coil. Furthermore, a reset spring is provided, which in this example is a compression spring 55a mounted within the damping member.

Blocking element 52 has its opposite end facing, in this example, the X-ray source and can intercept the X-ray beam from source 1 to slit S under the control of coil 54.

The blocking elements may be of lead but also of any other suitable material that attenuates X-rays, such as soft iron, bronze, gold and the like.

Fig.6 shows a variant of Fig.5. In the embodiment of Fig.6 the fixed members of the slit diaphragm are again denoted by 50 and 51. A U-shaped soft iron yoke is mounted between X-ray source 1 and the slit diaphragm, which yoke has its one leg 60 located adjacent the slit diaphragm and its other leg 61 spaced a distance therefrom. A resilient tongue 62 is attached to the top of leg 60, which tongue extends obliquely upwards and has its free end provided with a plate of magnetic material, for example magnet steel, which plate is situated above leg 61. A coil 64 is wound about leg 61 and is energizable by a control device comparable to control device 34 of Fig.3. Depending upon the control of coil 64, plate 63 is attracted to a greater or lesser extent by leg 61 to intercept to a lesser or greater extent the X-rays from source 1 to slit S.

It is observed that for controlling the blocking

of slit S over its entire length, a plurality of such yokes with resilient tongues as described is mounted in juxtaposition.

It is further observed that, in principle, the yoke may be so mounted that the leg carrying coil 64 is located adjacent the diaphragm, the resilient tongue being attached to the leg remote from the diaphragm.

Furthermore, in both cases the yoke may be located on the other side of the diaphragm, i.e., the side remote from the X-ray source.

Yet another possibility of moving the blocking elements in accordance with Figs. 2-4 from a position in which the slit is blocked to a position in which this slit is open and vice versa, is to connect each one of the elements through, for example, a rod via a suitable eccentric to a miniature motor operative to move the elements via the rod.

Fig.7 shows another variant of Fig.5. A plurality of rod-shaped piëzoelectric elements, one of which is shown in Fig.7 at 70, is mounted in juxtaposition on at least one of the fixed members of the slit diaphragm or on a suitable support. Such an element is straight in the rest position but arches in response to the application of a voltage across its opposing sides. This is shown in Fig.7. This known effect can be used for controllably blocking the slit diaphragm.

Such elements are available under the name of Bimorph Flexure Element.

As such elements usually contain lead, they can be readily used for the object contemplated. However, should the attenuating effect prove insufficient, the piëzoelectric elements may be coated with an X-ray absorbing material.

Fig. 8 shows yet another variant, in which use is made of a magnetic liquid for blocking the slit diaphragm.

A plurality of flat, hollow tubes 80 of plastics or glass containing a known per se magnetic liquid 81 is mounted in juxtaposition betw en X-ray source 1 and the slit diaphragm. Pole pieces 82 are provided at the top of each tube, which pole pieces are interconnected by a coil core about which a coil 83 is wound. Upon coil energization, the magnetic liquid is attracted by the pole pieces to move in front of slit S, thereby locally intercepting the X-rays from X-ray source 1.

It is observed that the above describes only a few examples of methods for locally blocking the slit-shaped opening of a slit diaphragm. Other methods will be readily obvious to the worker in the art after reading the foregoing.

The example of an apparatus for slit radiography shown in Fig. 1 employs an elongate proximity focus tube as an X-ray detector. Such a tube comprises an elongate cathode provided in known manner with a material operative to convert X-radiation into light quanta, and with a material responsive to light quanta for releasing electrons. These electrons are drawn by an electric field towards an anode mounted parallel to the cathode and likewise of strip-like configuration, which anode is responsive to the electrons incident thereon for forming a light image.

The light detection device may consist of a series of photosensitive elements placed within the housing of the X-ray detector, or, alternatively, exterior of this housing. In the latter case, the light detection device may consist of a series of lenses each viewing a section of the anode and each followed by a photomultiplier tube.

The invention is also applicable to an apparatus for slit radiography that does not include a detector that moves with the pivotal motion of the X-ray source and the slit diaphragm but includes instead a large

X-ray screen exposed by the X-ray source when the latter performs its scanning motion. In that case, however, the light detection device should perform a scanning motion corresponding to that of the X-ray source at the back of the X-ray screen. Alternatively, the light detection device may be composed of, for example, vertically arranged strip-like photoconductors that absorp little X-radiation and are disposed at the front of the X-ray screen, where, in fact, light is produced as well.

If a light-tight film cassette is placed directly behind the X-ray screen, again a light detection device disposed at the front of the X-ray screen may be used, or, mounted behind the film cassette, either an X-ray detector performing a scanning motion and provided with a light detection device as described above or a second large X-ray screen converting the X-radiation passed by the film cassette into light and followed by a light detection device performing a scanning motion, may be used. In that case, however, there is the drawback of the film cassette affecting the X-ray spectrum but the advantage of the local blocking of the slit-shaped opening of the slit diaphragm is maintained.

The invention is further applicable to systems in which the scanning motion is a result of a rotation instead of a linear movement normal to the longitudinal direction of the slit.

All such modifications are deemed to fall within the scope of the present invention.

CLAIMS

1. A method for slit radiography, in which X-rays are emitted from at least one X-ray source and are formed into a planar, fan X-ray beam by a slit diaphragm disposed between the X-ray source and the body being irradiated, an X-ray detector disposed behind the body being irradiated collects the radiation having passed through the body, and for obtaining a complete X-ray shadow image the desired part of the body is scanned at least once, in which sections of detection means coacting with the X-ray detector, which sections are arranged in juxtaposition in the longitudinal direction of the strip-like portion of the X-ray detector irradiated via the slit diaphragm, produce electrical signals depending upon the radiation instantaneously incident on the associated section of the X-ray detector, the slit diaphragm comprising a plurality of controllable elements, arranged in juxtaposition in the longitudinal direction of the slit, which plurality corresponds to that of the sections of the detection means, characterized in that the X-ray source performs at least two scanning motions and during the subsequent scanning motions X-rays of each time higher hardness are emitted, the electrical signals of the sections of the detection means being sampled during each scanning motion the sampled signal values being stored in a memory and during each next scanning motion the corresponding signals of the preceding scanning motion being retrieved from the memory to energize those controllable elements that each time correspond to the section of the detection means that produced an electrical signal exceeding a predetermined value at a corresponding instant during the preceding scanning motion, the controllable elements

section-wise blocking the slit diaphragm.

2. A method according to claim 1, characterized in that X-rays of a different hardness are emitted by each one of a plurality of X-ray sources, which plurality corresponds to that of the scanning motions performed for making a single radiograph.

3. An apparatus for slit radiography comprising at least one X-ray source, an X-ray detector disposed behind a body being irrediated to collect the radiation having passed through the body, and a slit diaphragm disposed between the X-ray source and the body being irradiated to form a planar, fan X-ray beam, in which for obtaining a complete X-ray shadow image of the desired part of the body the fan beam performs at least one scanning motion, and detection means are provided to coact with the X-ray detector, which detection means comprise a plurality of sections arranged in juxtaposition in the longitudinal direction of the strip-like portion of the X-ray detector irradiated via the slit diaphragm, each section being adapted to produce an electrical signal depending upon the radiation instantaneously incident on the associated section of the X-ray detector, the slit diaphragm comprising a plurality of sections arranged in juxtaposition in the longitudinal direction of the slit, which plurality corresponds to that of the sections of the detection means, each of which sections coacts with at least one controllable element, means being provided to control said elements, characterized in that the X-ray source is arranged for performing at least two scanning motions and the X-rays emitted during the subsequent scanning motions each time have a higher hardness, that the electrical signals of the sections of the detection means are sampled during each scanning motion, that the sampled signal values are stored in a memory, and that during each next scanning motion, the corresponding signals of the preceding

scanning motion are retrieved from the memory to be applied to the control means, which control means energize those controllable elements that each time correspond to the section of the detection means that produced an electrical signal exceeding a predetermined value at a corresponding instant during the preceding scanning motion, the energizing signal being adapted to cause the controllable elements to block section-wise the associated sections of the slit diaphragm.

4. An apparatus according to claim 3, characterized in that there is provided a plurality of X-ray sources each emitting X-rays of a different hardness, which plurality corresponds to that of the scanning motions performed for making a single radiograph.

5. An apparatus according to claim 3 or 4, characterized in that the juxtaposed sections of the slit diaphragm are formed by the provision of a plurality of elements arranged in juxtaposition and movable relative to each other in a direction normal to the longitudinal direction of the slit diaphragm, which elements are each coupled to a movable core of a coil energized by a control device.

6. An apparatus according to claim 5, characterized in that the juxtaposed elements are of trapezoidal section.

7. An apparatus according to claim 5, characterized in that the juxtaposed elements interlock through tongues and grooves.

8. An apparatus according to claim 3 or 4, characterized in that each section of the slit diaphragm coacts with at least one elongate element extending essentially normal to the longitudinal direction of the slit, which element is adapted to have one end moved into the beam emitted by the X-ray source under the control of the control means for so intercepting said beam.

9. An apparatus according to claim 8, characterized

in that the elongate elements are mounted for pivotal movement at a point between their ends to one of the members of the diaphragm or to a support extending parallel thereto, and that at least some of the elements each have one of their ends coupled to a movable core of a coil energized by the control means.

10. An apparatus according to claim 8, characterized in that at least some of the elements comprise a resilient tongue having one of its ends attached to one leg of a U-shaped coil core and having the other of its ends carrying a plate of magnetic material extending to above the other leg of the U-shaped coil core.

11. An apparatus according to claim 10, characterized in that each resilient tongue coacting with a U-shaped coil core is elastically connected to adjoining elongate and similarly oriented elements not coacting with a U-shaped coil core.

12. An apparatus according to claim 8, characterized in that at least some of the elongate elements comprise a piëzoelectric element having one of its ends mounted in registry with one of the members of the slit diaphragm which piëzoelectric element is responsive to a voltage applied thereto by the control means for so arching that its free end locally blocks the slit.

13. An apparatus according to claim 8, characterized in that at least the free end of each elongate element is coated with X-ray attenuating material.

14. An apparatus according to claim 3 or 4, characterized in that each section of the slit diaphragm is provided with a tube spanning the slit, which tube is partly filled with a magnetic liquid that can be drawn to before the slit under the influence of a magnetic field generated by an electric magnet energized by the control means.

15. An apparatus according to claim 3 or 4, characterized in that each blocking element is eccentrically

connected through a link means to the shaft of a motor controlled by the control means.

16. An apparatus according to claim 3, characterized in that the X-ray detector is an elongate image intensifier tube of the proximity focus type which moves in synchronism with the scanning motion of the X-ray source and the slit diaphragm and converts the X-rays collected into a light image; and that the detection means comprise a series of photosensitive elements coupled to the elongate tube, which element each view an associated portion of the light image and produce an electrical signal proportional to the amount of light collected instantaneously.

17. An apparatus according to claim 16, characterized in that the series of photosensitive elements is mounted within the elongate tube.

18. An apparatus according to claim 3, characterized in that the X-ray detector is a stationary X-ray screen which is scanned by a photosensitive detector comprising a plurality of juxtaposed sections in synchronism with the scanning motion of the X-ray source and the slit diaphragm.

19. An apparatus according to claim 3, characterized in that the X-ray detector is a stationary X-ray screen coupled in light-tight fashion to a film cassette, and that behind the film cassette there is mounted a second X-ray detector which collects the X-rays passed instantaneously by the film cassette and converts said X-rays into corresponding amounts of light which are measured by means of a series of photosensitive elements in synchronism with the scanning motion of the X-ray source and the slit diaphragm and are converted into corresponding electrical signals.

20. An apparatus according to claim 3, characterized in that the X-ray detector is a stationary X-ray screen, and that the detection means comprise juxtaposed strips

of a photoconductive material absorbing little X-radiation, which strips are disposed on the side of the X-ray screen facing the body being irradiated to extend normal to the scanning direction.

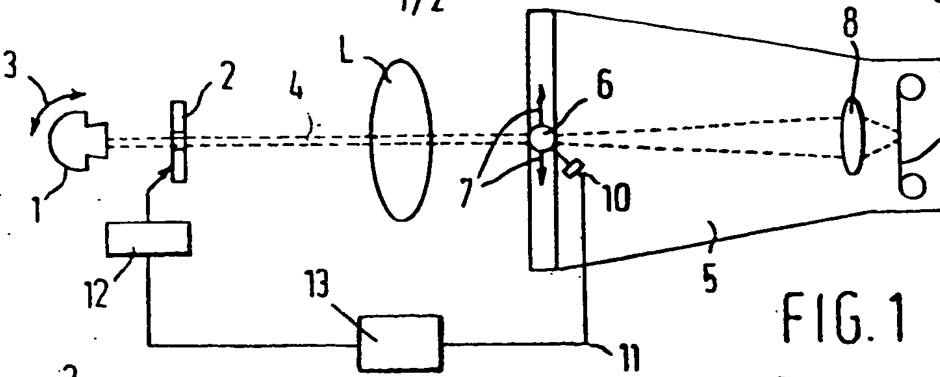

FIG.1

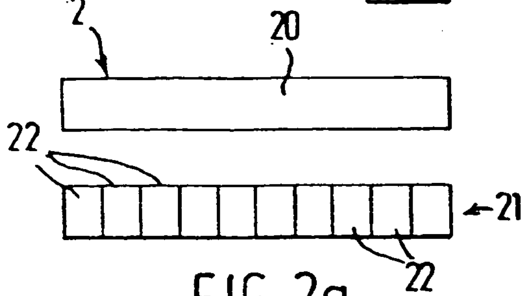

FIG.2a

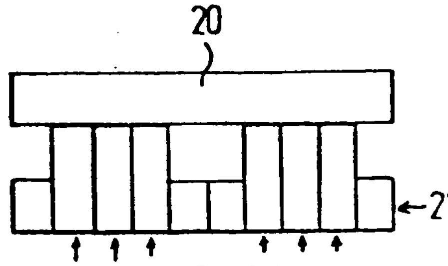

FIG.2b

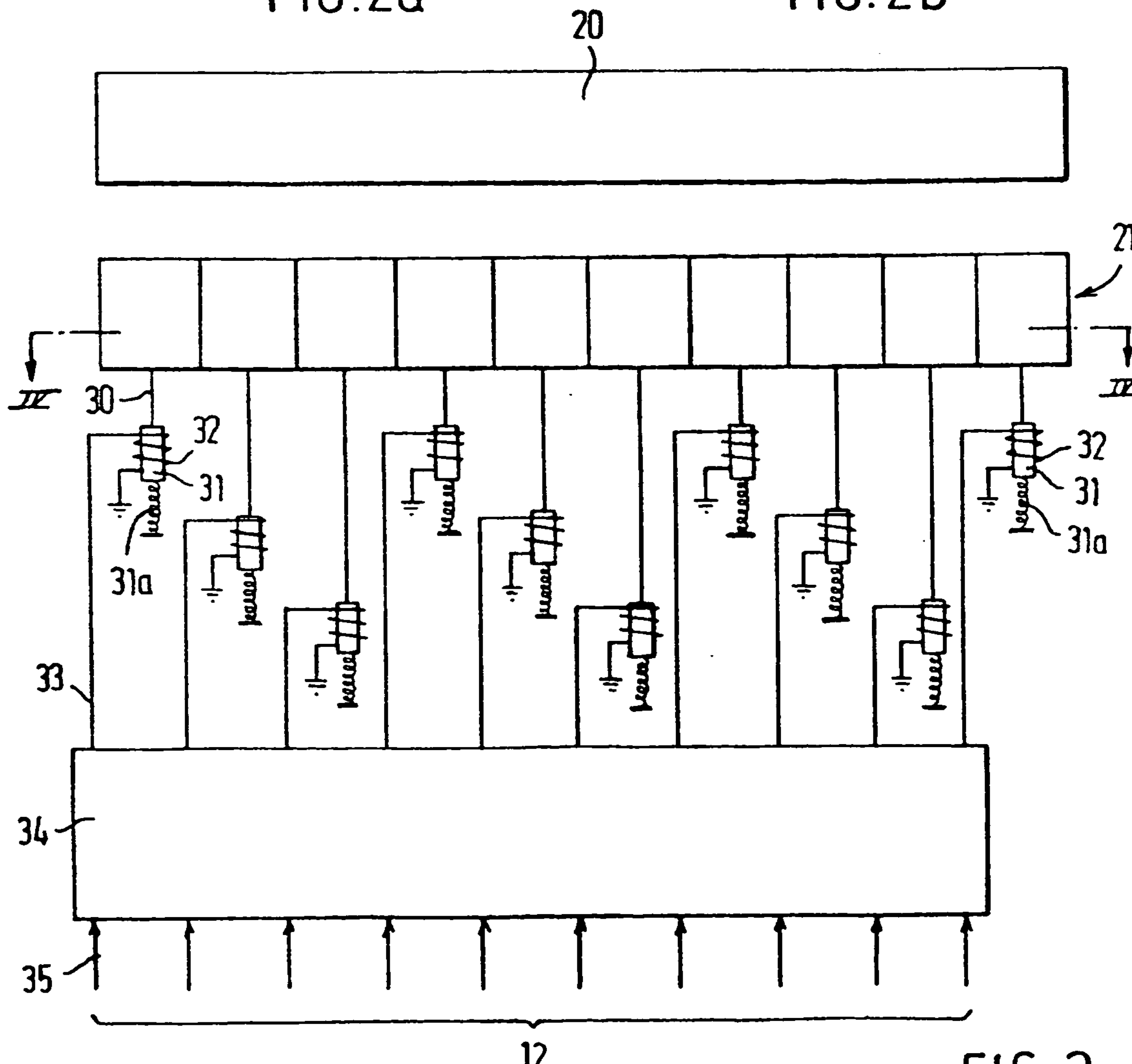

FIG.3

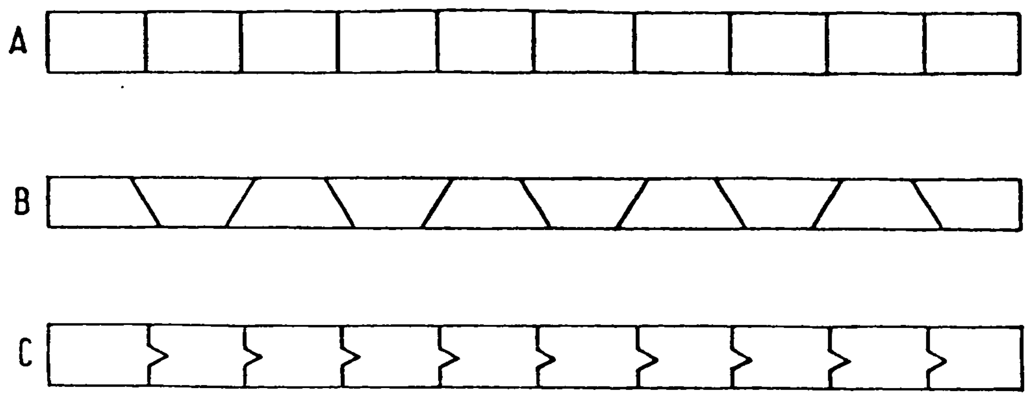

FIG.4

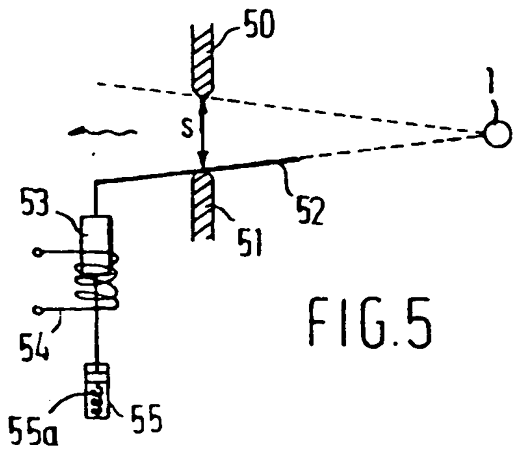

FIG.5

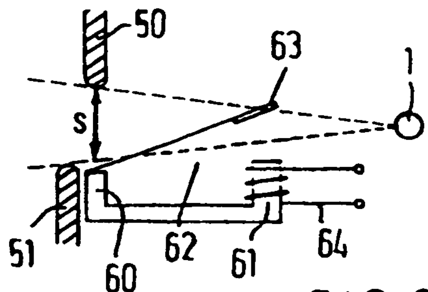

FIG.6

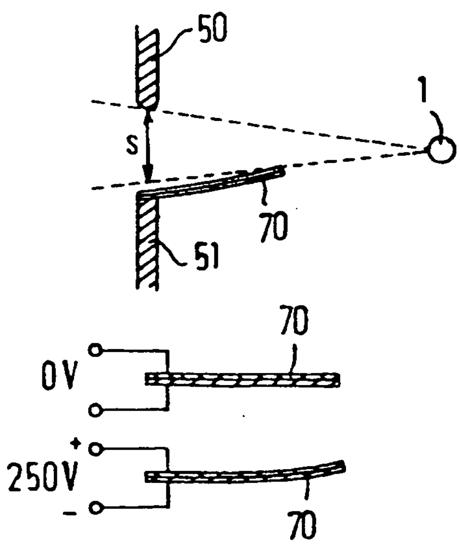

FIG.7

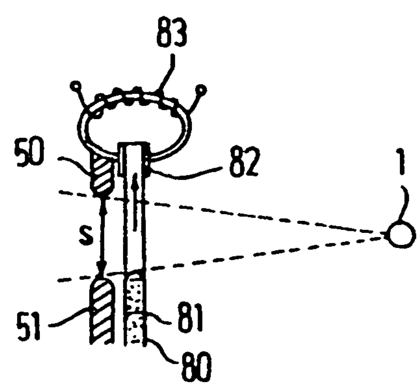

FIG.8

0209930

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which under Rule 45 of the European Patent Convention shall be considered, for the purposes of subsequent proceedings, as the European search report

Application number

EP 86 20 1082

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
D,P,Y	EP-A-0 158 382 (DE OUDE DELFT) * Abstract; pages 23-29; claims 1-4, 6,7,9-15,17,18,20,26; figures 1-8 *	1,3	A 61 B 6/00 A 61 B 6/06 H 05 G 1/26
A		5-20	
	& NL-A-84 00 845 ---		
Y	US-A-4 029 963 (R.E. ALVAREZ et al.) * Abstract; column 2, line 62 - column 3, line 4; column 8, lines 3-62; column 9, lines 4-7,29-35, 50-54; figures 1-3 *	1,3	
A		2,4,19	

A	US-A-3 755 672 (P. EDHOLM et al.) * Abstract; column 4, lines 59-68; column 5, lines 9-19,55-63; column 6, lines 52-66; column 7, line 15 - column 8, line 53; column 10, lines 5-64; figures 1-3,9 * ---	5,13, 19,20	TECHNICAL FIELDS SEARCHED (Int Cl.4) A 61 B H 05 G G 21 K

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INCOMPLETE SEARCH

The Search Division considers that the present European patent application does not comply with the provisions of the European Patent Convention to such an extent that it is not possible to carry out a meaningful search into the state of the art on the basis of some of the claims.

Claims searched completely: 3-20

Claims searched incompletely:

Claims not searched: 1,2

Reason for the limitation of the search:

Method for treatment of the human or animal body by surgery or therapy (see art. 52(4) of the European Patent Convention).

Place of search	Date of completion of the search	Examiner
The Hague	29-09-1986	RIEB

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DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	
A	FR-A-2 485 790 (COMP. GEN. DE RADIO-LOGIE) * Page 3, lines 18-35; page 4, lines 18-30; page 5, lines 13-24; figures 1,2 * -------	5,6,13 20	
			TECHNICAL FIELDS SEARCHED (Int. Cl.4)